Through School To Nation

Changkat Changi Secondary School

UNIT 10.3 & 10.4

Light--Refraction

Name: _____

Class: _____

Date: _____

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Lesson Summary & My Reflections

NOTES 10.3

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- Define refractive index of a medium in terms of ratio of the speed of light in vacuum to that in the medium

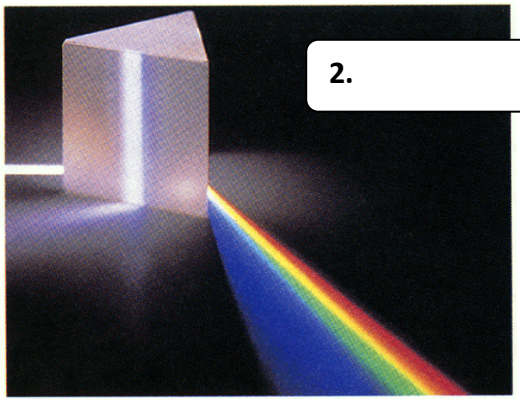
BUILDING UP YOUR OWN UNDERSTANDING

Bending of light

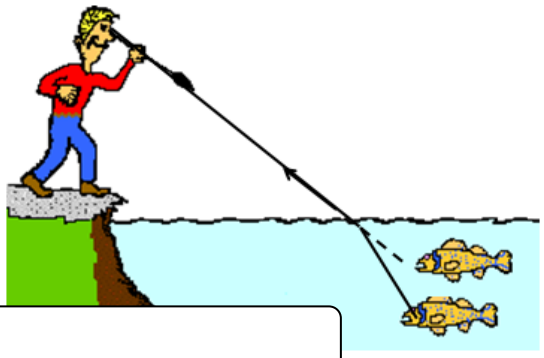
Light can travel through transparent materials such as glass, water or plastic. However, light will bend as it travels between two different optical medium.

This can be observed in our daily lives in some examples shown below.

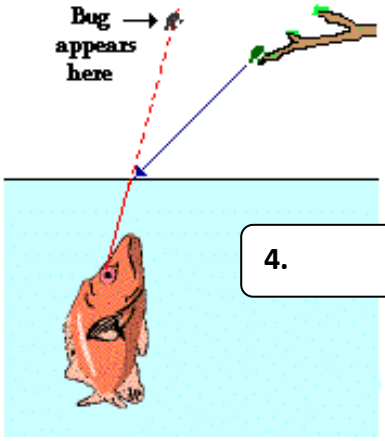
1.



2.



3.



4.

Learn more! Watch these two videos to understand more about examples 2,3 and 4.

Example 1: http://www.youtube.com/watch?v=FM1g1zNuCM0

Example 3: http://www.youtube.com/watch?v=oOLbdCSBa9o

Example 4: http://www.youtube.com/watch?v=fhBZ40jIo4Q

Definition of refraction

Refraction of light is the bending of light ray as it passes from one medium into another due to the

_____.

For example, in air or vacuum, light travels at a speed of 3.0 x 10^8m/s whereas in glass, light slows down to a speed of 2.6 x 10^8 m/s.

EXPLORE 1: Bending behaviour of light

Fig 1 and 2 shows how light bends between mediums of different optical density(e.g. air to water, water to air)

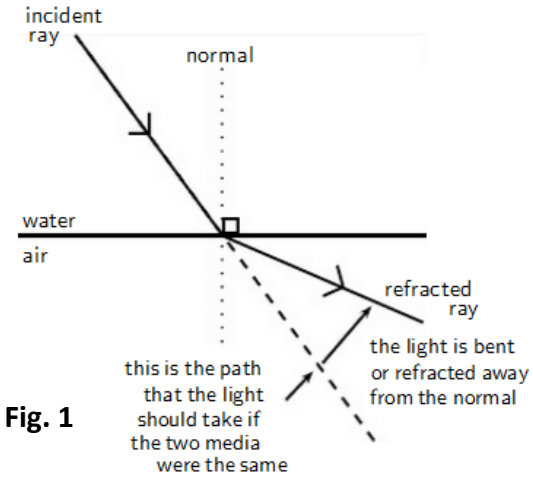


Fig. 1

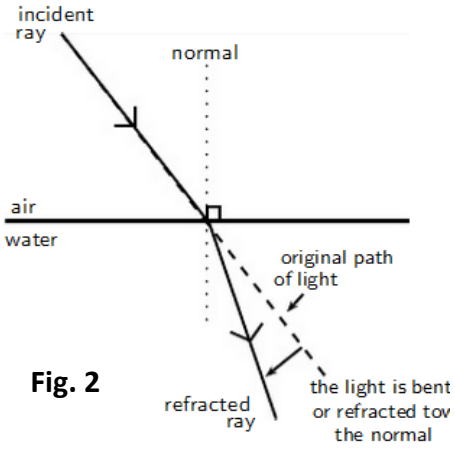


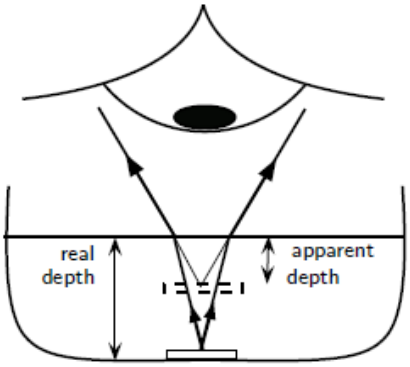
Fig. 2

A way to remember this:

- As light move from an optically less dense medium into an optical **Denser** medium, light ray bends **Towards** normal. **[D—T]**
- As light move from an optical denser medium into an optically **Less dense** medium, light ray bends **Away** normal. **[L—A]**

Further examples of refraction and ray diagrams

Figure below illustrates why a coin in water appears to be shallower due to refraction.



NOTES 10.4

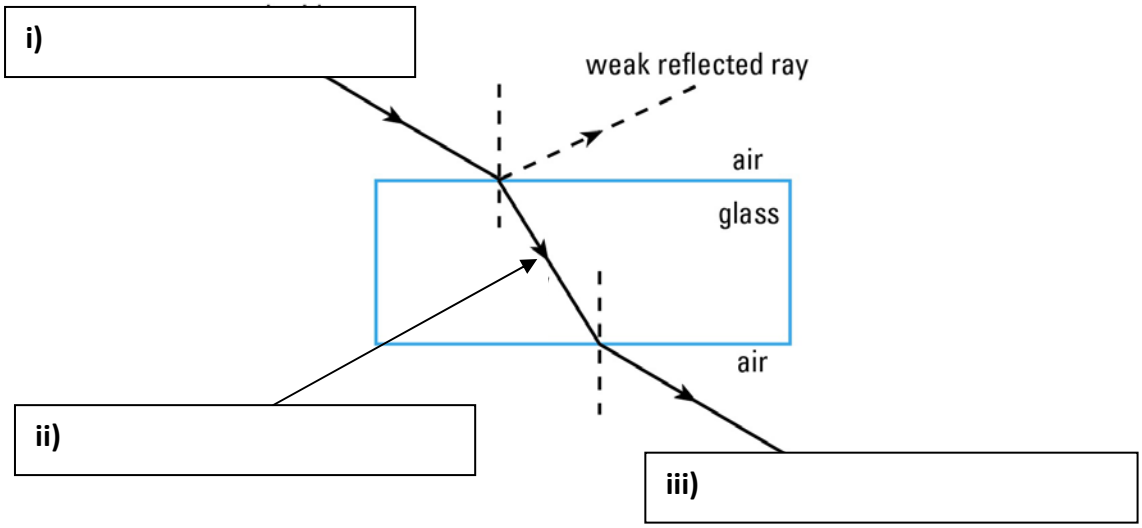
LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- Understand the terms used for refraction:
  - Normal
  - Angle of incidence
  - Angle of refraction
- Recall that $\frac{\sin i}{\sin r} = \text{constant}$, and solve related problems

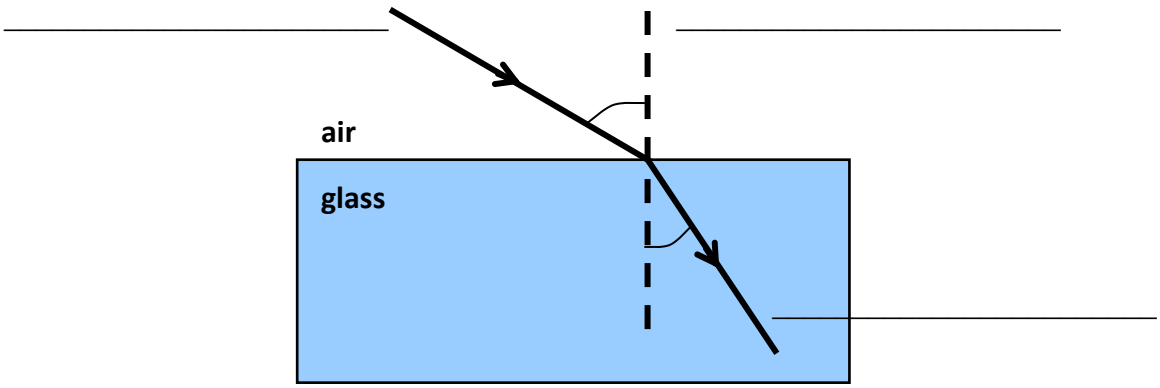
Refraction in a rectangular glass block

Figure below shows a light ray traveling from air into glass, and then into air again.



Different names are given for each ray in a glass block to help differentiate the rays at different parts. These names are **incident ray, refracted ray and emergent ray**.

Terms used in a ray diagram for refraction of light



Where *i* = angle of incidence (for air),
r = angle of refraction (in glass)

Laws of refraction

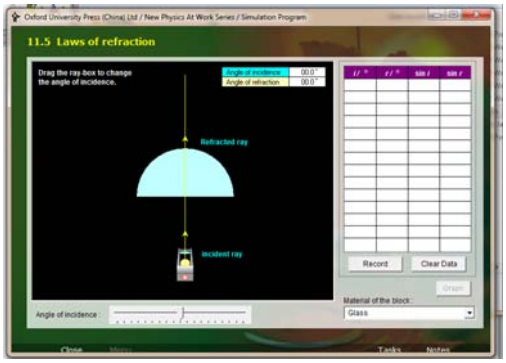
1. The _____, the _____ and the _____ all lie in the same plane.

2. For two particular media, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant, i.e. $\frac{\sin i}{\sin r} = \text{constant}$

Explore 2: Explore if sin i and sin r are always constant

Instructions

1. Open the applet " Laws of reflection". You will see a beam of light passing from air into a semi-circular glass block.



2. Use material glass for this exercise.

3. Move the ray box such that angle of incidence reads 20.0°. You will see the angle of refraction as well.

Angle of incidence	20.0°
Angle of refraction	13.2°

4. Click "record" Record and write down the readings of r/°, sin i and sin r in Table 1 below. Calculate the value of sin i/sin r to 3 s.f.

i/°	r/°	sin i	sin r	sin i/ sin r
20				
30				
40				
50				
60				

5. Repeat this for other values of i/° and record any other reading of i/° for the last row.

6. Discuss with teacher if sin i/sin r is always constant or if there is a range.

Refractive index, n, in terms of angles

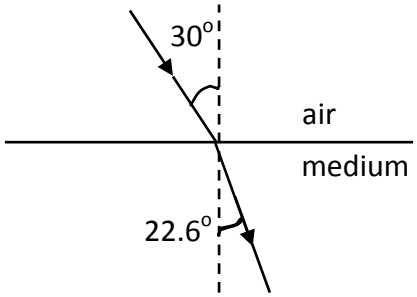
In fact, the constant value of sin i/sin r is defined as the refractive index, n.

- For the case of a light ray traveling from air into a medium such as glass, we can write

where *n* is the refractive index of the medium.
(Take note that for this formula to be used, i is the angle in _____)

Example

A ray of light travels from air to an unknown medium as shown below. Calculate the refractive index of the medium.



Your workings:

A	1.32	**B**	1.30	
C	0.768	**D**	0.978	( )

Explore 3: Determining refractive index

1. Can you determine the refractive index of other materials in table below?

Material	i/°	r/°	Refractive index, n = sin i/ sin r
Glass	20	13.2	
Perspex	30	19.5	
Water in a dish	35	25.5	
Diamond	40	15.5	

2. You may use your applet to verify your answer.

3. Rank the materials based on their refractive index starting from smallest to highest.

……

Smallest----------→ Highest

Refractive index, n , in terms of speed

- Previously, we also define refractive index as **ratio of** the speed of light in air /vacuum to the speed of light in a medium.

Therefore, we can write

$$n = \frac{c}{v}$$

where c represents the speed of light in vacuum/air,
v represents the speed of light in medium

Example
Light travels at 3.0×10^8 m/s in air and 2.6×10^8 m/s in the glass. Calculate the refractive index of the glass for blue light.

n = c/v
= 3.0×10^8 **/** 2.6×10^8
= 1.15

Refractive index of optical mediums

Table 2 summarises the refractive index of different media and their respective speeds.

Medium	Refractive index *n*	Speed of light ($\times 10^8$ m s^{-1})
Diamond	2.40	1.25
Glass	1.50*	2.00
Perspex	1.50	2.00
Water	1.33	2.25
Ice	1.30	2.30
Air	1.00	3.00

* For glass, the refractive index varies from 1.48 to 1.96, depending on the composition of the glass

How does the speed of light changes refractive index changes?